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Neutron transport methods for accelerator-driven systems
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A Monte Carlo model of an Accelerator Driven System (ADS) has been developed using the MCNPx code. Our MCNPx model consists of the following major components. (see also our June 2003 report)

1. The proton accelerator tube (Fig. 1)
2. The target
3. Six nuclear fuel assemblies placed symmetrically around the accelerator tube in a cylindrical geometry.
4. A "blanket" placed between the assemblies and at the periphery of the ADS

Three different models have been developed representing three levels of homogenization . Model 1: Individually modeled fuel rods in each assembly. (Fig. 2) Model 2: Homogenized fuel assemblies in water. Model 3: Homogenized rings of water and water plus nuclear fuel. Neutron fluxes have been computed for the three models and comparisons made. In addition, the neutron fluxes were computed for the three models with and without transuranics (TRU) in the fuel.

The results of the calculations have been presented at the ANS meeting in November 2003 (ANS Trans. V. 89, p. 635-637) and also incorporated in the M.S. Thesis of Jamie Ferrero at the University of Missouri-Rolla.

A parallel effort developed deterministic computational methods for an ADS. The work is cosponsored by Argonne National Laboratory with the objective that the computational methods will be incorporated into the ANL code systems, and particularly into the variational nodal methods contained in the VARIANT code system. The computational methods development contains two thrusts: the development of an R-Z geometry option for VARIANT, and an effective means of treating vacuum regions. The first is needed for many scoping calculations, the second in order to treat the vacuum region created by the beam tube found in accelerator driven systems.

The work on R-Z geometry completed through early 2004 has been reported in the proceedings of the PHYSOR 04 meeting held in Chicago. The paper (by Zhang *et. al.*) is attached. Since that time both the fixed source and the eigenvalue capabilities of the code have been generalized to treat spherical harmonics approximation through P5. Final testing and documentation of the code is in progress, and a journal article for *Nuclear Science & Engineering* is in preparation. All of these tasks should be completed before the end of the zero cost extension period.

The effort to find an effective method for forming response matrices that are both compatible with VARIANT and treat vacuum regions has been carried out in close collaboration with work at Argonne National Laboratory. Treatment of void regions has indeed turned out to be a challenging problem. However, success was achieved through the use of first -order form of the spherical harmonics equations. Results were reported at the PHYSOR 04 meeting. The paper (by Smith *et. al.*) is attached. Thus far, only X-Y geometry has been treated successfully. However, extension to R-Z geometry, once X-Y geometry is mastered, appears to be less of a challenge.

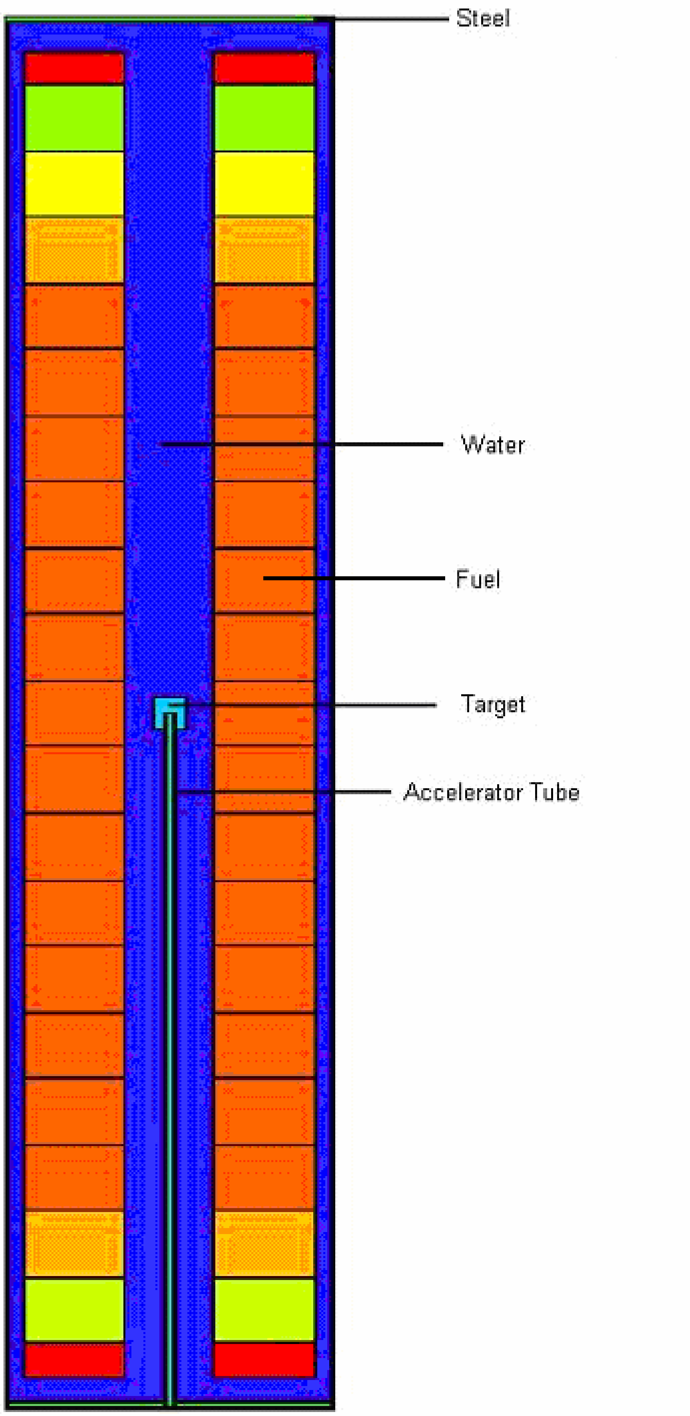
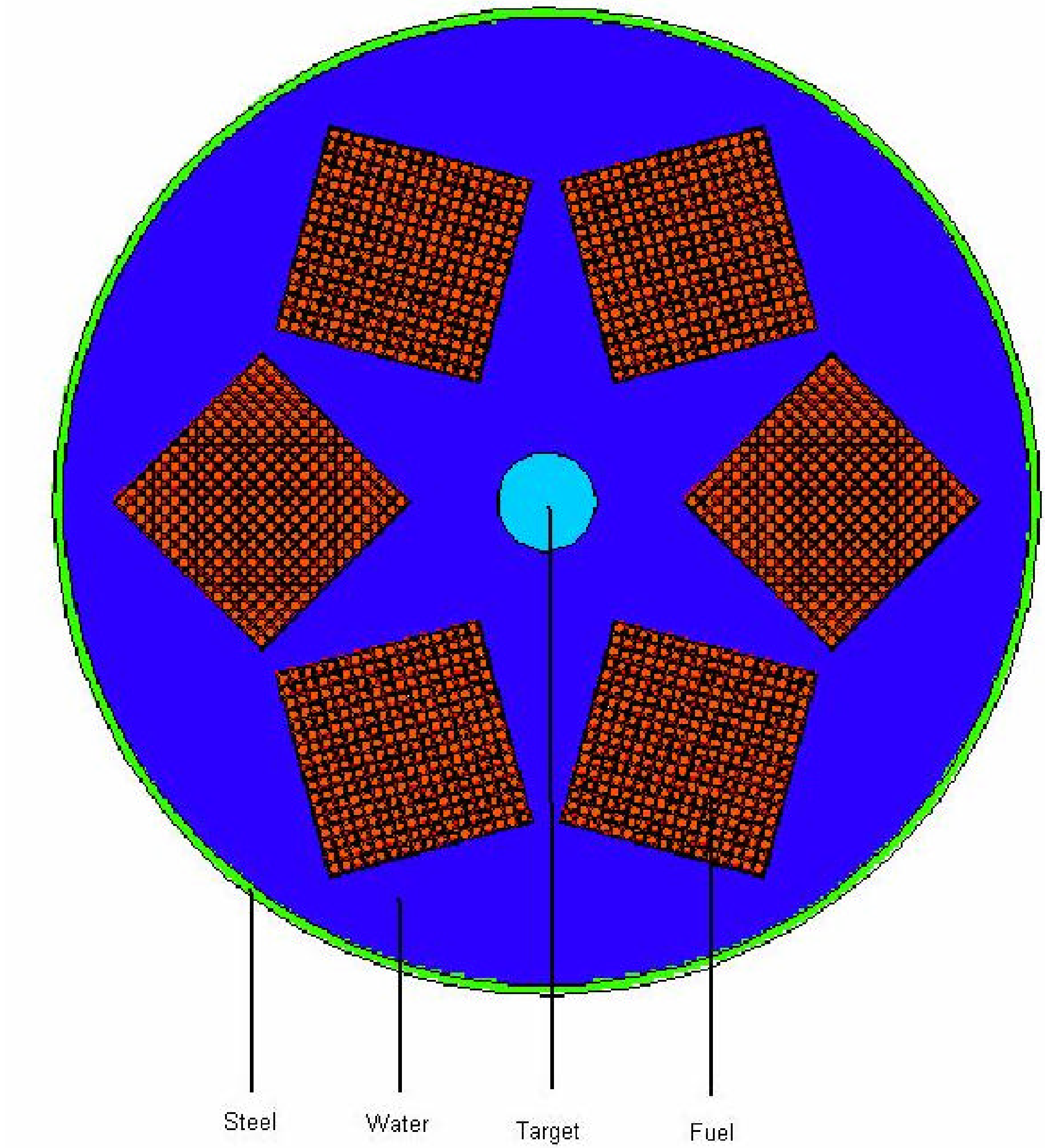


Figure 1. x-z view of homogenized assemblies model



Firgure 2. x-y view of detailed model with rods present in assemblies